

CLAIMS

The invention is claimed as follows:

1. A device for providing a medical fluid to a patient comprising:
  - 5 a plurality of capacitor plates;
  - a fluid receptacle positioned between the plurality of capacitor plates;
  - a circuit electrically connected to the plurality of capacitor plates, the circuit having an output indicative of a volume of the fluid in the fluid receptacle; and
  - 10 a member for providing at least a portion of the volume of the fluid to or from a patient.
2. The device of Claim 1, wherein the receptacle operates with a pump chamber having at least one fluid port.
- 15 3. The device of Claim 2, wherein the capacitor plates have a shape that is substantially the same as the shape of the pump chamber.
4. The device of Claim 1, wherein the receptacle includes at least one flexible membrane wall movable to pump medical fluid.
- 20 5. The device of Claim 1, wherein the receptacle includes first and second flexible membrane walls, at least one of the first and second membrane walls being movable to change a volume of the receptacle.
- 25 6. The device of Claim 1, wherein the receptacle includes a portion of a disposable dialysis fluid flow path useable with a dialysis machine.
7. The device of Claim 1, wherein at least one capacitor plate of the plurality of capacitor plates has a non-planer shape.

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8. The device of Claim 1, wherein the capacitor plates have a shape substantially the same as the fluid receptacle when the fluid receptacle is substantially full of fluid.

5 9. The device of Claim 1, wherein the circuit charges the capacitor plates and measures a change in voltage from the capacitor plates over a time interval.

10 10. The device of Claim 1, wherein the circuit further comprises:  
a ground connection to one of the capacitor plates; and  
10 a capacitance sensor circuit connected to another capacitor plate.

11. The device of Claim 1, which includes a pair of substantially parallel capacitor plates.

15 12. A device for providing dialysis to a patient comprising:  
a plurality of capacitor plates;  
a receptacle for holding a volume of dialysis fluid positioned between the plurality of capacitor plates;  
a circuit electrically connected to the plurality of capacitor plates, the circuit  
20 having an output indicative of the volume of dialysis fluid in the receptacle; and  
a fluid line coupled to the patient to deliver at least a portion of the volume of dialysis fluid to or from the patient.

25 13. A device for providing continuous flow peritoneal dialysis comprising:

a dialysis receptacle capable of being placed in fluid communication with a patient;  
first and second capacitor plates having a variable dielectric between the plates that is dependent on an amount of dialysis fluid in the receptacle; and  
30 an electrical circuit connected to the capacitor plates that creates a signal that is related to the variable dielectric.

14. A system for measuring a volume of a fluid to be provided to or from a patient, the system comprising:

a fluid receptacle capable of being fluidly connected to a patient;

5 first and second capacitor plates having a variable dielectric between the plates that is dependent on an amount of a fluid in the fluid receptacle; and

an electrical circuit connected to the capacitor plates that creates a signal that is related to the variable dielectric.

10 15. The system of Claim 14, wherein the signal is indicative of the volume of the fluid in the fluid receptacle.

16. The system of Claim 14, wherein the signal is indicative of a volume of air in the fluid receptacle.

15 17. The system of Claim 14, wherein the signal is indicative of a portion of fluid and a portion of air in the fluid receptacle.

18. The system of Claim 14, wherein the fluid receptacle operates inside 20 of a fluid pump chamber.

19. The system of Claim 18, wherein the capacitor plates have a shape substantially the same as the fluid pump chamber.

25 20. The system of Claim 14, wherein the fluid receptacle is positioned between the first and second capacitor plates.

21. The system of Claim 14, further comprising a pump piston, wherein one of the first and second capacitor plates defines an aperture that allows a portion 30 of the piston to extend outside the plate.

22. The system of Claim 14, further comprising a pump piston, wherein the pump piston moves between the capacitor plates.

23. The system of Claim 14, further comprising a displacement fluid that 5 expands and contracts the fluid receptacle to fill and empty the fluid in and out of the receptacle.

24. The system of Claim 14, which includes a pump chamber wall defining a port that can apply a negative pressure to the receptacle and pull at least a 10 portion of the membrane towards the port.

25. The system of Claim 14, which includes a pair of pump chamber walls each defining a port.

15 26. The system of Claim 14, wherein at least one of the first and second capacitor plates is represented by the surface of the adjacent fluid.

27. The system of Claim 14, wherein the fluid receptacle further comprises a disposable cassette, at least one wall of the cassette being a flexible 20 membrane.

28. The system of Claim 14, further comprising a processor that determines a volume of the fluid from the signal outputted by the electrical circuit.

25 29. The system of Claim 14, further comprising a processor that determines a cumulative volume of fluid from a plurality of individual volumes of fluid in the fluid receptacle.

30. The system of Claim 14, wherein the pair of capacitor plates have a 30 shape substantially the same as the receptacle when the receptacle is full of fluid.

31. A system for measuring a volume of a fluid to be provided to or from a patient, the system comprising:

a fluid receptacle that can be placed in fluid communication with the patient; first and second capacitor plates positioned outside of the fluid receptacle;  
5 and

an electrical circuit providing a voltage source that enables a signal indicative of the volume of the fluid in the receptacle to be generated.

32. The system of Claim 31, wherein the output signal is based on at least  
10 one of: a variable dielectric between the plates, a changing surface area of one of the plates, and a changing distance between the plates.

33. The system of Claim 31, wherein the signal is based on a varying dielectric constant between the fluid and air.  
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34. The system of Claim 31, wherein the circuit charges the capacitor plates and measures a change in voltage from the capacitor plates over a time interval.

20 35. The system of Claim 34, wherein the time interval is a fixed time interval.

36. A medical fluid delivery system, comprising:  
a fluid flow path including a patient connection;  
25 a fluid receptacle that is so constructed and arranged to be in fluid communication with the fluid flow path; and  
a capacitance sensor positioned relative to the fluid receptacle and capable of indicating a volume of fluid in the receptacle.

30 37. The system of Claim 36, wherein the fluid receptacle operates with a pump chamber.

38. The system of Claim 37, wherein the capacitance sensor further comprises first and second capacitor plates at opposite sides of the pump chamber.

39. The system of Claim 38, wherein the capacitor plates have a shape  
5 substantially the same as part of the pump chamber.

40. The system of Claim 36, wherein the capacitance sensor further comprises first and second capacitor plates positioned at opposite sides of the fluid receptacle.

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41. The system of Claim 36, wherein the capacitance sensor includes at least one capacitor plate having a non-planer shape.

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42. The system of Claim 36, wherein the fluid receptacle is part of a disposable set.

43. The system of Claim 36, wherein the capacitance sensor comprises first and second capacitor plates and an electrical circuit connected to the plates.

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44. The system of Claim 36, wherein the pair of capacitor plates have a shape substantially the same as the fluid receptacle when the fluid receptacle is substantially full of fluid.

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45. The system of Claim 36, wherein the medical fluid delivery system is a dialysis system.

46. The system of Claim 45, wherein the dialysis system is a continuous flow peritoneal dialysis system.

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47. A dialysis system, comprising:

a fluid flow mechanism capable of conveying a fluid during a dialysis treatment; and

5 a fluid volume capacitance sensor so positioned and arranged relative to the fluid flow mechanism to measure a volume of the fluid during the dialysis treatment.

48. The dialysis system of Claim 47, wherein the fluid flow mechanism is a continuous flow mechanism capable of performing continuous flow dialysis.

10 49. The dialysis system of Claim 47, wherein the fluid flow mechanism is fluidly connected to a peritoneal dialysis catheter.

50. The dialysis system of Claim 47, wherein the fluid flow mechanism is fluidly connected to a plurality of peritoneal access lumens.

15 51. A method of measuring a volume of a medical fluid pumped by a fluid pump, comprising the steps of:

sensing a first state of a fluid receptacle with capacitor plates when the medical fluid receptacle is substantially empty of fluid;

20 providing the medical fluid to the fluid receptacle;

sensing a second state of the fluid receptacle with the capacitor plates when the fluid receptacle is substantially full of medical fluid; and

determining a volume of the medical fluid in the fluid receptacle based on the first and second states sensed by the capacitor plates.

25 52. The method of Claim 51 further comprising the steps of:

substantially emptying the fluid receptacle of fluid; and

providing additional medical fluid to the receptacle, sensing another second state, and determining another volume of the medical fluid.

30 53. The method of Claim 51, which includes continuously sensing the state of the fluid receptacle as the fluid enters the receptacle.

54. The method of Claim 51, which includes determining a total volume of fluid from a plurality of volumes of medical fluid provided to the receptacle.

5 55. The method of Claim 51, which includes knowing a total amount of medical fluid needed by a patient and stopping the provision of the medical fluid when the total amount has been provided.

10 56. The method of Claim 51, which includes determining a volume of air in the fluid receptacle based on the first and second states sensed by the capacitor plates.

15 57. A method of providing dialysis to a patient, comprising the steps of: measuring a volume of dialysis fluid with a capacitance sensor; and passing a portion of the volume of the dialysis fluid into a portion of a patient.

58. The method of Claim 57, wherein the portion includes a peritoneal cavity of the patient.

.20 59. The method of Claim 57, wherein the measuring step further comprises measuring the volume of dialysis fluid in a pump chamber.

60. A method of providing continuous flow peritoneal dialysis to a patient, comprising the steps of:

25 passing a volume of dialysis fluid through a pair of capacitor plates to measure the volume of dialysis fluid;  
causing the volume of dialysis fluid to move into a portion of a patient; and  
removing dialysis fluid from the patient simultaneously as the volume of dialysis fluid is moved into the patient.

30 61. The method of Claim 60, wherein passing the volume of dialysis fluid through the pair of capacitor plates occurs at a fluid pump.

62. A method of providing dialysis to a patient, comprising the steps of:  
providing a dialysate;

5 measuring a volume of dialysate with a capacitance sensor;  
infusing the volume of dialysate into a patient; and  
drawing the dialysate from the patient.

63. The method of Claim 62, which includes infusing dialysate into the patient using a continuous flow peritoneal dialysis method.

10 64. The method of Claim 62, which includes visually indicating the measured volume to a person.

15 65. The method of Claim 62, wherein the measuring step further comprises measuring the volume of dialysis fluid in a pump chamber.

66. The method of Claim 62, which includes measuring a volume of air with the capacitance sensor.

20 67. A method of operating a system which displaces a medical fluid that is designed to be received by a patient, comprising the steps of:  
moving the medical fluid from a first location to a second location; and  
measuring a volume of the fluid moved by a capacitance sensor.

25 68. The method of Claim 67, wherein the measuring step further comprises measuring the volume of fluid in a pump chamber.

69. The method of Claim 67, further comprising the step of delivering the medical fluid to a patient.

30 70. The method of Claim 67, further comprising the step of performing dialysis with the medical fluid.

71. The method of Claim 70, wherein the performing dialysis step further comprises performing continuous flow peritoneal dialysis.

5 72. The method of Claim 67, which includes controlling an amount of the medical fluid needed to be moved by measuring the volume with the capacitance sensor.

10 73. The method of Claim 67, which includes indicating the amount of medical fluid moved to a patient.